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SPECIAL LOCAL NEED REGISTRATION APPLICATION

for

SODIUM MONOFLUOROACETATE (1080) GRAIN BAIT

to

CONTROL COLUMBIAN GROUND SQUIRREL DAMAGE
IN WESTERN MONTANA

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I. DESCRIPTION OF THE SITUATION

A. The Problem.

Livestock producers and farmers in western Montana are suffering significant losses of livestock forage and cultivated crops to the Columbian ground squirrel, because of a lack in registration of an effective control material or method. Damage caused by this species is widespread throughout most counties west of the Continental Divide and is locally severe. In a survey conducted by the Department of Livestock in 1973, local Rural Conservation Districts, and Committees for Rural Area Development estimated a loss to the Columbian ground squirrel of more than 1.2 million dollars annually. Rodenticides currently registered have proven ineffective in reducing agricultural damage by the Columbian ground squirrel to below the economic injury level.[1] Other control methods have been considered, but have proven ineffective.

Not only are there inadequate damage prevention methods available, but the Columbian ground squirrel is found under conditions most difficult for its control. Diversity in land ownership and the topography of western Montana additionally complicates matters. Private and state lands are intermingled and surrounded by federal lands where presently Columbian ground squirrel control has not been permitted.

B. Life History of the Columbian Ground Squirrel.

The Columbian ground squirrel has a relatively limited range in southern Canada, western Montana, northern Idaho, eastern Washington and Oregon (Burt and Grossenheider, 1964; Martin, Zim and Nelson, 1951). This species prefers relatively open country or forest edges. They

[1]Economic injury level is reached when damage to agricultural resources exceeds the cost of reducing or preventing the damage.

are commonly found in mountain meadows or open hillsides. Their altitudinal range is great, being found at all elevations from 700 to over 8,000 feet (Davis, 1939). Manville states that they are most prevalent in the Hudsonian Zone but also occur commonly in the Lower Canadian. Adults weigh 350 to 800 grams, making it the largest ground squirrel found in Montana. It is mottled grey-brown in color, with distinctive dark rufous patches on feet, legs and face.

The Columbian ground squirrel is dormant for six to seven months each year. In most areas they are active between March and August, but their active period varies with local conditions. The mature males emerge from hibernation 7 to 10 days before the females and younger males (Shaw, 1916). The breeding season takes place shortly after the females emerge. The gestation period is approximately 24 days (Shaw, 1925). Each female has from two to seven young per litter. Only one litter is produced each year. The young begin to emerge from the burrow at about three weeks of age. Moore (1937) found that the date of first emergence of young was delayed by one day for each 100-foot gain in altitude, and two weeks by an increase of one degree latitude. Presumably, the rest of their activity cycle is retarded or advanced accordingly. Almost immediately, the young being to disperse, digging new burrows or re-excavating abandoned ones. The young of the year do not breed until their second season.

The Columbian ground squirrel consumes a great variety of foods, including green herbage, flowers, seeds, bulbs, fruits, and occasionally insects. They are also known to kill and eat other wildlife species. Gladding (1938) reported that 30 of 96 California quail (Lophortyx californicus) nests under observation were robbed by Beechey ground squirrels (Spermophilus beecheyi beecheyi). Emlen and Gladding (1937)

observed a ground squirrel take three eggs from a pair of quail who attempted to guard the nest. A Franklin ground squirrel (Spermophilus franklinii) was photographed removing eggs from duck nests (Sprungman, 1951). Packard (1958) reported seeing a Mexican ground squirrel (Spermophilus mexicanus) carrying and eating a live cottontail rabbit. The Columbian ground squirrel is also known to be carnivorous (Manville, 1959). No record of nest-robbing was found in the literature, however, Record (1977) has found egg shells at the entrance to active Columbian ground squirrel burrows.

Some food storage in the burrows was noted by Shaw (1926). Forty-one hibernation nests were excavated and 21 contained stored food. Only one of the 21 burrows was inhabited by a male. Shaw theorizes that such storage, seen only in the males, might be related to the fact that the old males are the first to emerge from hibernation each spring and they may need a supplemental food supply if they encounter unfavorable weather conditions.

C. Impact of the Columbian Ground Squirrel on Agricultural and Natural Resources.

Damage caused by Columbian ground squirrels in western Montana is widespread and locally severe. A survey of Rural Conservation Districts and Committees for Rural Development put the dollar loss to crops and forage at $1,218,500.00 (Appendix A). Counties listing losses in excess of $100,000 each were Flathead, Deer Lodge, Powell, and Ravalli. This is a very conservative estimate and the true cost could be several times greater.

Competition with livestock for range forage is probably the most common damage problem associated with Columbian ground squirrels in western Montana. Squirrels destroy forage by eating, cutting and

discarding, trampling, using it for nest lining and covering it with excavated soil.

As much as 38 percent of rangeland yield may be destroyed by ground squirrels (Fitch, 1948). Shaw (1921) found that a squirrel ate about 17.2% of its own weight in clover each day. Horn and Fitch (1942) reported that a large ground squirrel burrow may displace as much as 20 cubic feet of earth. Much of this is piled on surface vegetation. In one field experiment, heifers grazing on pasture where squirrels had been controlled gained 1.03 lbs/day more weight than heifers in a pasture where squirrels had not been controlled (Howard, 1959).

Destruction of cultivated crops by Columbian ground squirrels can be locally severe. Cereal grains and alfalfa are probably the most affected in western Montana. Each ground squirrel may consume about 4.7 pounds of green foliage per month when it is available (Fitch, 1948).

Ground squirrels are opportunists that are able to utilize seemingly any food source made available by man's activities. In a field study by Howard and Wagnon (1951), 18 Beechey ground squirrels carried away 900 lbs. of surplus potatoes scattered in a field for cattle.

Little or no evidence is available that Columbian ground squirrel populations are important or strategic in the epidemiology of certain human diseases (plague, Rocky Mountain spotted fever, Colorado tick fever and tularemia). The ground squirrel, where involved at all, are minor and non-essential aspects of these diseases, and pose a negligible health threat (Skinner, 1977).

Longhurst (1957) documented that ground squirrel burrows may be

eroded by rain runoff. The burrow gradually enlarges until the earth crust breaks through, forming a gulley. Such erosion of ditchbanks and earthen dams could have potentially costly results.

Other problems created by ground squirrel populations include weed dissemination (DeVos, 1969), changing plant species composition of rangeland by selective feeding (Fitch and Bentley, 1949) and competing with other wild species for available food and habitat.

D. History of Columbian Ground Squirrel Damage Control in Western Montana.

The control of noxious rodents has been of major concern to the Montana farmer and rancher ever since the first prairie sod was turned under to make way for cultivated crops and livestock. Individual efforts were unable to cope with the situation, and in 1915, Congress appropriated funds for the United States Department of Agriculture to help people in the nation's agricultural industry to control noxious rodent pests on public and private lands.

Montana's first state-wide rodent control program was implemented in 1917 under the supervision of the Bureau of Biological Survey, USDA, in cooperation with the Montana Extension Service. By 1918, a rodent bait mixing plant and testing laboratory was constructed at Montana State University in Bozeman, Montana, with a revolving fund known as the "Montana State College Gopher Fund." Through this plant, individual settlers and ranchers obtained rodent control strychnine grain bait at County Agriculture Agent's offices. Annual reports indicate laboratory testing of new rodenticides, plus researching the effectiveness, selectivity and safety of strychnine, were carried on at the testing laboratory. Tests in 1924 were conducted concerning the effects of strychnine grain bait on Montana's game bird populations.

It was proven to have no effect (Stephl, 1925).

To facilitate the preparation of suitable rodent bait, the Bureau of Biological Survey, in cooperation with the Chamber of Commerce of Pocatello, Idaho, established a supply depot where rodent grain bait could be purchased for use in nearby states, including Montana. By 1937, this facility replaced the rodent bait mixing plant in Bozeman, Montana.

Under federal re-organization (1939), the responsibility for rodent control was transferred from the USDA to the Department of Interior, Fish and Wildlife Service. Research facilities for rodent control were developed in Denver, Colorado in an attempt to improve control methods.

Therefore, the testing laboratory at Montana State University was gradually phased out. This left Montana's rodent control program primarily in the hands of the Department of Interior for control and research with the Montana Extension Service acting primarily as an education media and distribution agency for rodent grain bait.

In 1947 the Montana Legislature authorized (Title 3, Chapter 27, Section 3-2701 R.C.M., 1947, "Control of Noxious Rodent Pests") the Montana Livestock Commission, since renamed the Department of Livestock, to cooperate and enter into written agreements with the U.S. Department of Interior in control of rodents injurious to agriculture, industry, and public health. A state Advisory Council representing the discipline of health, wildlife, livestock, and agriculture was appointed the same year to recommend programs concerning rodent control. This council remained in function until state re-organization in 1971, which then abolished standing advisory councils. Of primary consideration and review by the Advisory Council, Department of Livestock, and U.S.

Fish and Wildlife Service from 1947 to 1971 was the use of sodium monofluoroacetate (1080) and strychnine for rodent control.

From 1949-1963, the Montana Legislature appropriated $20,000 annually for rodent control. These funds were administered by the Montana Department of Livestock and expended in cooperation with the U.S. Fish and Wildlife Service. Most severe infestations of ground squirrels and prairie dogs were brought under reasonable control during these years through efforts of federal, state, county, and private organization participation. Sodium monofluoroacetate (1080) was used only under the direction of the U.S. Fish and Wildlife Service during this time period.

In the remaining years from 1964-1971, the U.S. Fish and Wildlife Service attempted to continue maintenance rodent control programs while farmers and ranchers regained more responsibility of rodent control on their own lands using strychnine grain baits. This situation arose primarily from discontinuance of legislative appropriations in 1964. Eventually in 1970, the U.S. Fish and Wildlife Service, due to a reduction of personnel, increased predator control requests, and lack of funding, terminated the maintenance program except for strychnine grain bait sold to local counties for distribution to private individuals.

Presidential Executive Order #11643, February 8, 1972, "Environmental Safeguards on Activities for Animal Damage Control on Federal Lands," forced the closure of the U.S. Fish and Wildlife Service Pocatello Supply Depot during the 1972 rodent control season in Montana. This was an additional hardship to Montana's livestock and agriculture industries since the Pocatello Supply Depot had been the source of supply for rodent control materials since the 1940's. What compounded

the problem was no other company could provide a rodent bait strong enough to control prairie dogs, Columbian ground squirrels, or pocket gophers. In addition, the Executive Order inadvertently disallowed all government employees from handling toxicants for rodent control, thereby eliminating any possible consideration for any field-oriented rodent control programs by the Department of Interior.

Due to these events, the Montana Department of Agriculture was instructed by Governor Anderson, April 25, 1972, to designate a special council, equally representing four basic disciplines; agriculture, health, livestock, and wildlife, to research the rodent and rabies control problem. This council was given the responsibility for developing appropriate legislation to provide for an organized program to control rodents effecting our food supplies and rabid skunks endangering the health of our citizens and livestock, while insuring that our environment was protected from any possible adverse environmental effects. Events leading to the appointment of the Advisory Council were:

1. President's Executive Order February 8, 1972 on predators and toxicants, the Department of Interior's subsequent actions, and the banning of certain predacides by the Environmental Protection Agency.
2. Numerous requests from farmers, ranchers, and urban residents for rodent control.
3. Proposed national legislation placing additional responsibility for control of rodents and rabid skunks to the states.

The Advisory Council made recommendations (Appendix B) in the following areas concerning rodent control:

1. Registration of rodenticides.
2. Restriction of rodenticides.
3. Department of Livestock responsibilities.
4. Operation of rodent control programs.
5. Appropriate legislation.

Utilizing the Governor's Advisory Committee's Final Report on Rodent and Rabid Skunk Control, the Montana Legislature in 1975 approved funding for the Department of Livestock to develop and coordinate a state program for the control of noxious rodent pests which were destroying food, fiber, or natural resources.

E. Current Columbian Ground Squirrel Damage Control Programs in Western Montana.

House Bill No. 404 (Appendix C) enacted by the 44th Legislature and approved by Governor Thomas Judge on April 3, 1975, permits the Montana Department of Livestock and counties to cooperate in the operation of rodent control programs. Additionally, House Bill No. 269 provides funding beginning July 1, 1975, for the Department of Livestock to develop and coordinate a state program for the management of noxious rodent pests which are destroying food, fiber, or natural resources.

The program was implemented in July 1975 with the following objectives:

1. To initiate and coordinate noxious rodent control activities in individual counties emphasizing damage assessment, training of control personnel, monitoring control strategies and recommending improved control programs.
2. To evaluate noxious rodent control methods used in all habitat types and under various climatic conditions based upon effec-

tiveness, selectivity, economic feasibility, environmental safety, and demonstrated need.

3. To establish an information-education program at the county level on the control of noxious rodent pests by biological, chemical, and mechanical methods; eg., pamphlets, brochures, radio, television, newspapers, magazines, etc.
4. To determine the types and degrees of socio-economic damage caused by noxious rodents in various ecosystems throughout the state.

A major portion of the Department of Livestock Rodent Control Program is the extensive involvement of County Commissioners, Rodent Control Boards, and County Extension Agents in the design and implementation of rodent damage control programs specific to the needs of each county. To accomplish these objectives, the following recommendations were offered to each Board of County Commissioners:

1. Commissioners establish a County Rodent Control Board. This Board may consist of County Commissioners, County Extension Agents, County Sanitarians, RAD Committee Members, producers, etc.
2. Commissioners designate a county employee, preferably the Extension Agent, to coordinate this program with the Department of Livestock. The coordinator may serve as chairman of the Rodent Control Board and be responsible for news releases at the local level.
3. A Department of Livestock Rodent Control Biologist will work with the County Coordinator and Board to develop a program to meet the specific needs of the county.
4. The Department of Livestock will train control personnel,

assess rodent damage, monitor control strategies, recommend improved control methods, and establish an information-education program on rodent control for each county.

5. Funding for training of control personnel will be provided by the Department of Livestock.
6. Funding for control personnel materials and equipment used in the county will be the responsibility of the county.

The County Commissioners in thirteen northwestern Montana counties named Rodent Control Boards to work in conjunction with the Department of Livestock on the Columbian ground squirrel problem.

Most counties where Columbian ground squirrel damage is severe purchase 0.5% strychnine bait from the U.S. Fish and Wildlife Service Pocatello Supply Depot for resale. Bait is made available to producers at cost. The bait is commonly sold by the County Weed Control Office because their personnel has the Pesticide Dealers Licenses required by state and federal law. The bait is sold by other licensed pesticide dealers, such as grain elevator operators, in some counties. Strychnine grain bait sold by the U.S. Fish and Wildlife Service in Montana for Columbian ground squirrel control during calendar years 1974 through 1976, was 4,575, 4,835, and 9,635 pounds respectively (Hoover, 1977).

Flathead and Powell counties funded Columbian ground squirrel control programs during 1976. Certified Licensed Pesticide Applicators, trained by the Department of Livestock, assisted producers by organizing local control efforts, demonstrating and supervising the correct application of bait. The general consensus of those involved is that these organized programs achieve more of the control objectives than the strictly individual system, but that control was still not satis-

factory. The records of the Flathead County Rodent Control Supervisor show that control (measured by number of animals active prior to, vs. after, baiting) averaged approximately 70-75%. This percentage in reduction of Columbian ground squirrel populations did not provide a corresponding decrease in damage. (See pages 29-30 for discussion on adequate population control percentages for prevention or reduction of Columbian ground squirrel damage.)

Dissatisfaction with control success achieved seems to be almost universal. Of 75 farmers and livestock producers questioned in a 1976 survey, 49% said their control success in the previous year had been poor. In some cases their poor results are probably due in part to improper baiting techniques, such as baiting at the wrong time of the year, or not covering the treated area thoroughly. However, even under the best of conditions in closely supervised and properly conducted control operations in Flathead County, the results were still unsatisfactory. Some possible explanations of the strychnine bait's poor performance are discussed in the Special Local Need section.

II. REQUEST FOR REGISTRATION OF SODIUM MONOFLUOROACETATE FOR COLUMBIAN GROUND SQUIRREL CONTROL IN WESTERN MONTANA

A. Special Local Need Determination.

There is a substantial body of evidence testifying to the fact that the Columbian ground squirrel in Montana is a special case requiring different control materials than other species or even the same species found in other northwestern states. In the classic Revision of the North American Ground Squirrels, Howell (1938) recognizes two races of Spermophilus columbianus. The typical form, Spermophilus columbianus, occurring in the majority of the species range, is the one found in Montana. Spermophilus columbianus ruficaudus ranges in northeastern Oregon and extreme southern Washington.

This racial delineation apparently has a very practical application in the case of the Columbian ground squirrel. Gabrielson (1932) makes the following statement:

> "In Montana, northern Idaho, and eastern Washington, the Columbia (sic) ground squirrel (Citellus (sic) columbianus) is one of the most difficult to handle. Strychnine is much less effective against this rodent in this territory than in northeastern Oregon, and for many years this was not understood. In 1928, when the species was divided into two races, the line of demarcation followed closely the boundary that had been noted in the differences in reactions to poisons."

This phenomenon is not limited to the Columbian ground squirrel. Two races of the California ground squirrel Spermophilus beecheyi provide another example. Spermophilus beecheyi beecheyi is quite difficult to control with strychnine, while Spermophilus beecheyi douglasi is not. At the species level, strychnine appears to be more effective in reducing Richardson ground squirrel damage in grain-producing areas that border the distribution of the Columbian ground squirrel. Strychnine has not proven effective against the Columbian

ground squirrel.

U.S. Department of Agriculture, Bureau of Biological Survey personnel initiated the use of strychnine grain baits for Columbian ground squirrel control in western Montana during the 1920's and 1930's. Listed below are statements recorded by these personnel concerning the efficacy of strychnine grain baits for Columbian ground squirrel control:

> "Control measures against this pest are complicated by nature of topography, that is, the intermingling of valleys and forested mountain ranges, and because of the fact that a high percentage of kill is more difficult to obtain." (Omah, 1923)
>
> "In studying bait spots (strychnine) it was interesting to note that in many cases the squirrels baited had evidently sampled the bait and rejected it. On the other hand, some squirrels started right in to eat the bait, staying with it until they became sick and died." (Stephl, 1926)
>
> "The Columbian ground squirrel is of special concern in Montana because of the difficulty experienced in controlling them with methods now employed." (Stephl, 1928)
>
> "In 1926 and 1930 the Bureau of Biological Survey conducted tests to improve the acceptance of strychnine grain bait for Columbian ground squirrel control. Although interesting data on the effects of various ingredients regarding the acceptance of bait was secured, no radical changes in control methods were developed." (Stephl, 1930).
>
> "Various poison formulas and methods are being used, yet a satisfactory poison preparation is still lacking." (Stephl, 1931)
>
> "For a long time it was believed that the squirrels objected to the bitter taste of the strychnine, but now other factors are thought more likely to be responsible. It is quite possible that the squirrels experience the toxic effect of the poison and stop eating the oats before having consumed a fatal quantity. Frequently also the bait may be eaten but at intervals so that a lethal dose is never present in the squirrel at one time." (Stephl, 1931)

Further evidence of the inability of strychnine to effectively control Columbian ground squirrel populations is seen

in the results of a 1976 survey of farmers and ranchers conducted by the Department of Livestock. Of those responding, 7% rated their degree of control of Columbian ground squirrels as Good, 44% Fair, and 49% Poor.

Bait efficacy trials for Columbian ground squirrel control were conducted in Powell and Flathead counties during June and July, 1976 by the Montana Department of Livestock. Ground squirrel numbers were reduced 64% using 0.5% strychnine on steam-rolled oat groats, 68% and 81% using 0.5% strychnine on crimped ("Pocatello") oats, and 95% and 99% using Compound 1080 on steam-rolled oat groats (see Appendix D). The precise reason for strychnine's inadequate performance has not been confirmed, but the toxicology of strychnine and the ecology and ethology of the Columbian ground squirrel provide the basis for two possible answers.

Strychnine is commonly termed a "pouch" poison (USDA, 1932). This means it is more effective when absorbed through the lining of the squirrel's cheek pouches than the stomach or intestine walls. In fact, one-fifth of the amount of strychnine needed to produce death through stomach absorption will kill a squirrel if it is absorbed through the cheek pouches (Merriam, 1910).

Some species of ground squirrel pouch a great deal of grain, particularly in late summer or fall. Other species do not. S. b. beecheyi does not. This might explain their differential responses to the toxicant.

Field studies were conducted during the summer of 1976 to determine if and when Columbian and Richardson ground squirrels pouch grain. Initial results indicate some pouching in Richardson, but little or no pouching in Columbian ground squirrels. These results tend to

support the hypothesis that pouching, or the lack of it, is a major key to the success or failure of strychnine grain baits (Record, 1977).

The second possible explanation for the difference in species response to strychnine baits relates to food or bait preference. Two characteristics of strychnine that are known to impede its effectiveness in some cases are its bitter taste and short latent period. This combination is undesirable because the fast action can cause illness before a lethal dose is consumed and the taste provides a readily available cue with which the squirrel can associate its illness. This can lead to poison or bait shyness. The problem can be overcome only if the squirrel readily accepts the toxic bait and consumes a lethal dose before the onset of poisoning symptoms causes it to cease eating. Sodium monofluoroacetate, on the other hand, is essentially tasteless and exhibits a relatively long latent period.

Green food is available to the Columbian ground squirrel in western Montana throughout its active season. Several authors mention that this species has at least a seasonal preference for green food (Shaw, 1916; USFWS, undated). Baiting is usually not recommended until late in the active season when grain baits are usually better accepted. This apparent preference for green food and the constant availability of it to the western Montana Columbian ground squirrel, may also contribute to the lack of success with strychnine baits.

B. Sodium Monofluoroacetate.

1. History: Sodium (mono)fluoroacetate is a nonvolatile, water soluble, white, essentially tasteless crystalline powder. Fluoroacetic acid was first prepared by Swartz in 1896 (Pattison, 1959). He did not record any knowledge of its properties as a toxicant.

Further research on fluoroacetate and its homologs was not conducted until 1934, when German scientist Schrader noted its toxic properties. His work led to fluoroacetic acid salts being patented as rodenticides in Germany. The Polish scientists Gryszkiewicz-Trochimowski and colleagues also conducted research on the compounds in the late 1930's. They escaped to England in 1942, where they turned the results of their research over to British Intelligence. The British further researched the toxic properties of the compounds and turned the results over to the American government, requesting cooperative research. The U.S. Fish and Wildlife Service began studies on the use of sodium monofluoroacetate, which they dubbed "Compound 1080," as a rodenticide in 1944.

2. Toxicology: The toxic action of Compound 1080 takes place in the citric acid (Krebs) cycle. Fluoroacetate enters the cycle in the same manner as does acetate. It then forms fluorocitrate, which blocks the enzyme aconitase. This blocks the citric acid cycle. All tissues are effected, but functional changes in the heart and central nervous system seem to be the proximal cause of fatality in species tested.

Compound 1080 exhibits a very broad range of toxic doses among different species. According to Atzert (1971) (Appendix E), the LD50 values range from 0.05 mg/kg for the pocket gopher, 0.1 mg/kg for the coyote (Canis latrans), 0.3 mg/kg for the Fishers ground squirrel (Spermophilus fisheri) and 0.9 mg/kg for the Columbian ground squirrel (Spermophilus columbianus) to as much as 8.55 mg/kg to 14.6 mg/kg for the mourning dove (Zenaidura macroura), 10 mg/kg for the mallard duck (Anas platyrhynchos), and 20 mg/kg for the Gambles quail (Lophortyx gambeli), 10 mg/kg for several species of raptor including the marsh

hawk (Circus exaneus hudsonius) and great horned owl (Bubo virginianus pallescens), 15 mg/kg for the black vulture (Coragyps atratus), and 20 mg/kg for the turkey vulture (Cathartes aura). Amphibians are even more resistant to Compound 1080.

The differential toxicity of Compound 1080 is an important factor in protecting non-target species from primary and secondary hazards. However, it should be recognized that some potentially exposed non-target species such as the canine and feline families are quite susceptible to Compound 1080. Therefore, precautions taking into account the ecology and biology of the Columbian ground squirrel and non-target species must be taken. This has been done successfully and those procedures are outlined in the "Non-Target Species Considerations" section.

3. Antidote and First-Aid Procedures: The potential hazard of 1080 poisoning in humans has precipitated research efforts around the world to develop a successful antidote for 1080 poisoning. Investigators including Tourtellotte and Coon (1951), Chenoweth et.al. (1951), Pattison (1959), Noguchi et.al. (1968), and Thomas (1975) have evaluated many compounds and treatment procedures. Pattison (1959), for example, discovered that monoacetin (glyceryl monoacetate), acetamide, and combinations of sodium acetate and ethanol have all shown some therapeutic effects in monkeys and other animals. The protective action of both monoacetin and acetamide is due to the liberation of active acetate (acetylcoenzyme A) for competition with the toxic material 'active fluoroacetate.'

Noguchi et.al. (1968) used acetamide effectively to eliminate mortality in rats and guinea pigs after injecting them with a lethal dose of monofluoroacetate. Effective treatment procedures involved

intra-muscular injection rates of 300 mg. of acetamide per kilogram of animal body weight, three times per day, over a five-day period.

Chenoweth et.al. (1951) found monoacetin to be an effective antagonist to fluoroacetate (0.1 mg/kg) poisoning in the dog, provided that enough monoacetin be given over a sufficiently lengthy treatment period.

More recently, Japanese cases of 1080 poisoning have recovered from an acetamide treatment involving dose rates between 30 and 100 grams of acetamide administered per patient per day (Thomas, 1975). A 50 percent (W/V) water solution of acetamide was prepared using extra pure reagent. The solution was then packed in 50 ml. ampules that were added to a dextrose solution and administered intravenously to the patient (Thomas, 1975). Cases of 1080 poisoning resulted from consumption of 1080 treated rodent baits.

Additional first aid that should be administered to anyone consuming sodium monofluoroacetate consists of immediate emesis and gastric lavage followed by an oral dosage of magnesium or sodium sulphate to remove the chemical from the alimentary tract and prevent absorption of a lethal amount (ASTM, 1976). The patient should then be kept quiet and barbiturates administered to control convulsions.

C. Efficacy of Sodium Monofluoroacetate for Reducing Columbian Ground Squirrel Damage.

Probably the least controversial aspect of the use of Compound 1080 for ground squirrel control is its efficacy. A high degree of control is reported by nearly all researchers using it. Spencer (1946) noted "excellent" control of Columbian ground squirrels in field operations during some of the original field testing of the compound in this country.

Department of Interior, U.S. Fish and Wildlife Service personnel implemented the use of 1080 grain bait for Columbian ground squirrel control in western Montana beginning in 1946. Listed below are statements recorded by these personnel concerning the efficacy of 1080 grain baits for Columbian ground squirrel control:

> "In Flathead County 1080 was introduced for control of Columbian ground squirrels. The results were phenomenal, strengths of 2-100 and 1-100 gave 100% control. About 25,000 acres were treated in the Stillwater and Whitefish river areas. The balance of the area treated with 1-10 strychnine, made a bad showing against the 1080 bait." (Bateman, 1946)

> "It would be our recommendation that 1080 grain be used entirely for Columbian ground squirrels. The strychnine baits have never given the expected results in our cooperative program." (Bateman, 1946)

> "Observations based on acceptance and kill indicate the period for exposing 1080 bait for Columbian ground squirrels appears to be from May 15 to July 15, the optimum period being about June 10 to July 10. After June 10 the young squirrels are above ground and acceptance is high. Exposure tests from May 5 to May 8 resulted in low acceptance and poor kill." (Beebe, 1947)

> "Results with 1080 bait continued exceptionally good; kills averaging 95% to 98%, however, May and June were unusually wet months which hampered operations considerably." (Grand, 1948)

Ninety-five and 99 percent control of Columbian ground squirrel populations was achieved in two field tests conducted by the Department of Livestock (Record, 1976), of the Compound 1080 grain bait formulation recommended in this application for registration. Descriptions of these field tests are found in Appendix D.

D. Non-Target Species Considerations.

The Environmental Protection Agency requires that a pesticide product must be shown to "not cause unreasonable adverse effects on the environment when used as directed or in accordance with widespread

and commonly recognized practice." Compound 1080 grain baits have been used for field rodent control since the mid-1940's. EPA further states that there is "no validated field evidence" that the use of 1080 has resulted in significant population reductions in non-target species or in the deaths of members of endangered species. This fact demonstrates that 1080 grain baits are selective for the target rodent species when used properly.

Selectivity is too often defined only in terms of the relative physiological susceptibility of the target and non-target species to the toxicant. This ignores an important facet of the science of vertebrate pest control. That is the degree of selectivity that can be achieved by understanding the ecology and behavior of the target and non-target species in each area and utilizing this knowledge in the formulation and application of toxic grain baits. The following is a discussion of some of the techniques and procedures that can greatly enhance the selectivity of toxic grain baits for field rodent control

1. Timing: Timing of bait application is not only important in achieving the highest efficacy with a given bait, it also can be an important factor in reducing non-target species hazard. Bait should only be applied during the seasons when the entire ground squirrel population is active and accepting grain. Increased consumption of grain baits by ground squirrels will decrease bait exposure to non-target species. These seasons of optimum bait acceptance are known for the Columbian ground squirrel and can be determined locally with the methods outlined by Dana (1962). See Appendix F.

2. Bait Placement: The proper placement of toxic grain bait

is an important factor in reducing non-target species hazard. Bait should be scattered by the entrance to each active burrow. It should not be placed in the hole because squirrels are not accustomed to foraging there and will often reject bait so placed. Neither should bait be piled; this does not increase acceptance and may create a hazard to some non-target species (Klaustermeyer and McGlothlen, undated). Properly scattered bait poses no hazard to domestic livestock except in extremely overgrazed situations. No sheep, cattle, or horses were reported lost in extensive ground squirrel control operations using 1080 grain bait in Colorado, California, and Oregon (Spencer, 1945).

3. Formulation: Much is known about means of formulating baits that present the least possible hazard to non-target seed-eating bird species. Three of the most important factors in preventing birds from consuming lethal quantities of bait are bait color, size, and shape.

Proper selection of the grain to be used as the carrier of the toxicant is very important. Small grains such as milo and wheat should never be used for ground squirrel bait. They are too readily eaten by birds. The majority of ground squirrel bait formulas specify oats or oat groats (Clark, 1975) because larger grains are less accepted by birds but are well accepted by ground squirrels (Gabrielson, 1932).

Alteration of grain shape also decreases acceptance by birds (Dana, 1962). It is theorized that rolled or crimped grains appear "unnatural" to birds, thus creating suspicion.

Dyeing of grain baits significantly decreases acceptance by birds (Kalmbach and Welch, 1946; Pank, 1976). Ground squirrels, however, are colorblind and therefore exhibit no such rejection of dyed baits

(McNeill, 1977). The chance of accidental use of toxic grain baits as livestock feed or accidental human consumption are also decreased by dyeing the bait.

All of the above-listed factors were considered in choosing the bait formula proposed in the application for registration (Appendix G). The bait will utilize steam-rolled oat groats and National Brilliant Yellow dye.

E. Proposed Use Restrictions for Sodium Monofluoroacetate Grain Baits Used for Reducing Columbian Ground Squirrel Damage.

The safe use history of 1080 is related to use practices that have been developed by professionals using toxic grain baits for field rodent control. The following use restrictions are proposed as a formalization of commonly recognized practices based on the ecology and biology of the target and non-target species and the toxicology of Compound 1080:

(1) Use of Compound 1080 grain bait shall conform to all applicable federal, state and local laws and regulations.

(2) Applicators shall be subject to such other regulations and restrictions as may be prescribed from time to time by the U.S. Environmental Protection Agency and Montana Department of Agriculture.

(3) Compound 1080 grain bait shall be used only in the twelve listed Montana counties: Broadwater, Flathead, Granite, Lake, Lewis & Clark, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders and Silver Bow.

(4) Each applicator shall be trained in:
   (a) the biology and ecology of the Columbian ground squirrel,
   (b) safe handling of the toxic grain baits,
   (c) proper placement of the bait,
   (d) consideration of environmental conditions before baiting is begun,
   (e) necessary record keeping,
   (f) and other competency standards.

(5) Compound 1080 grain bait shall be used only under the special[2] (on-site) supervision of Certified Government Pesticide

[2]"Special supervision" means that a certified-licensed applicator or licensed applicator must be physically present at the time of use and application of a pesticide.

Applicators trained by the Montana Department of Livestock and licensed by the Montana Department of Agriculture.

(6) Compound 1080 grain bait shall be used only to control Columbian ground squirrels (Spermophilus columbianus) in areas where they are causing damage to food crops, fiber crops, or range resources.

(7) Compound 1080 grain bait shall not be used in situations where threatened and endangered animal species will be adversely affected.

(8) The amount of Compound 1080 grain bait used shall be the minimum necessary to reduce losses to below the economic injury level as a rule, but the maximum allowable shall be one tablespoonful of bait scattered by each active burrow.

(9) A calibrated dipper shall be used to apply the bait.

(10) All persons authorized to possess and use Compound 1080 grain bait shall store such bait in locked containers.

(11) All bait removed from locked containers for use shall be carried only in zippered canvas pouches marked in red letters "POISON GRAIN". The bag shall remain closed at all times except when actually applying bait.

(12) Each Certified Government Pesticide Applicator shall keep records dealing with the placement of Compound 1080 grain bait. Such records shall include, but not be limited to:
   (a) the approximate number of acres upon which bait is applied,
   (b) the amount of bait applied,
   (c) the dates of each application,
   (d) all accidents or injuries to humans, domestic animals, or non-target species,
   (e) the time, location, name of product, pest to be controlled, and the name of the applicator.

(13) Bait shall not be piled or placed in holes, but shall be scattered by each active burrow entrance.

(14) Gloves shall be worn by all persons handling Compound 1080 grain bait.

(15) Persons applying the bait shall wash their hands before eating or smoking. Washing facilities shall be made readily available by the supervising Certified Government Pesticide Applicator.

(16) Compound 1080 grain bait shall be applied only during seasons when Columbian ground squirrels are accepting grain, and the majority of the population is active

above ground. These seasons shall be determined locally by the Certified Government Pesticide Applicator in consultation with the Department of Livestock Vertebrate Pest Control Biologists.

(17) Compound 1080 grain bait shall be applied no more than once per year.

F. Alternatives

1. No Control: One option is to exert no controls on high Columbian ground squirrel populations injurious to agriculture. Natural population regulators such as predation, disease, inter- and intra-specific competition and natural catastrophes would be relied upon to regulate the populations.

The advantages of this alternative are that there would be no chemical, mechanical or biological controls introduced into the environment. There would be no cost to individuals or government for control materials and labor.

The disadvantages to this alternative are that agricultural and natural resource loss to high squirrel populations is likely to exceed the economic injury level. If this alternative is pursued, a method for compensating the producer for his loss should be devised.

2. Trapping: Trapping of ground squirrels can be a "practical means of control for ground squirrels where other methods are unsatisfactory or undesirable" (Clark, 1975). Live "box" traps are sometimes used to trap squirrels. March and Plesse (1964) developed a kill trap for ground squirrels by modifying a wooden box-type pocket gopher trap. This type of trap is somewhat more effective than the live catch designs. Some researchers have reported success with steel jaw traps (Horn and Fitch, 1946). Properly maintained traps can be quite selective and humane. Trapping may be conducted at any time

when ground squirrels are active. Trapping is best suited to the removal of small local populations or for individual animals.

There are several disadvantages to trapping in a large-scale control operation. One is that it requires a major investment to purchase the traps. This could, however, be depreciated over the useful life of the traps and is therefore not a major consideration. The biggest disadvantage to trapping is the amount of labor involved and the time required to conduct a control operation using only traps on large acreages. Hagan (1972) stated that trapping was an expensive and ineffective means of ground squirrel control.

3. Shooting: Shooting with a .22 caliber or high-powered rifle is a highly selective method of controlling small populations of ground squirrels. Ground squirrel or "gopher" shooting is a popular spring sport in western Montana.

The disadvantages to shooting are that it is limited to relatively non-populated areas, requires a large labor cost, and is difficult to reduce squirrel populations to below the economic injury level.

4. Exclusion: The high cost of constructing squirrel-proof fences makes this impractical except in the case of very small plantings such as flower beds or gardens.

5. Flooding: Repeated extensive flooding used in flood-irrigated crops does serve to limit the number of ground squirrels present. It would be impractical, however, to apply this method to field control operations due to the topography and limited availability of water in most areas. It would also have far-reaching effects upon non-target plant and animal species.

6. Repellents: There is no validated field evidence that any repelling devices or products are effective in preventing damage caused by ground squirrels. There are two basic problems with the concept of repellents for field rodent control. First, repellency requires a sort of "value judgement" on the part of the squirrel. Once the attractive value of an area (food, mate, shelter) exceeds the repellency, the squirrel will tolerate the repellent. Displaced ground squirrels are also likely to infest adjoining properties. Until more is known about ground squirrel behavior, it is unlikely that effective repellents will be developed.

7. Land Use Modification: It is commonly believed that overgrazing is a major cause of ground squirrel overpopulation. However, Howard (1953) found that any amount of grazing of California grassland would increase ground squirrel numbers. A significant reduction in ground squirrel numbers would require almost complete exclusion of grazing (Fitch and Bentley, 1949; Horn and Fitch, 1942).

Where practical rest-rotation or other management practices may be of value in an integrated ground squirrel management program, their use as the sole damage control method would be impractical.

8. Disease Introduction: Introduced diseases were used to alleviate overpopulations of wild rabbits in Australia. Myxoma virus was introduced and impressive reductions in rabbit numbers took place during the early years of the program. The disease's effectiveness has not continued, however, due to resistance development in the host species and attenuation of the virus strains (Cherrett, et.al., 1971; Marshall and Fenner, 1960).

There are several other problems inherent in disease introduction

programs. The potential for epidemic in other species of wildlife and domestic animals is high because of the lack of host specificity of the most effective introduced diseases. Man is unable to control the spread of such diseases once they are introduced. Man himself may even be infected by strains of diseases that develop from those introduced.

Until much more is known and understood about epidemiology and vertebrate ecology, we must be extremely careful about introducing diseases into the environment. There is evidence that their effectiveness may be short-lived.

9. Fumigants. A number of toxic gasses were once used for ground squirrel control. Among these are methyl bromide, carbon bisulfide, and the gas cartridge (mostly carbon monoxide). Methyl bromide and carbon bisulfide are no longer registered for this use. The gas cartridge, which is ignited before being placed in the burrow, is still available.

The major disadvantage to fumigants is the amount of labor and costs required to carry out a control program with them. Each burrow must be treated in at least one entrance and all other entrances must be sealed to prevent the escape of the gas. Fumigants work well in follow-up control operations where ground squirrels are still causing damage.

10. Strychnine Grain Bait: The only products currently available for Columbian ground squirrel control in Montana are strychnine-treated grain baits. One formulation lists 0.5% strychnine (active) ingredient, the other lists 0.44%. The 0.5% on slightly crimped "Pocatello" oats is the one commonly used in western Montana. It is

manufactured by the U.S. Fish and Wildlife Service Supply Depot in Pocatello, Idaho.

These strychnine baits have not been effective in reducing Columbian ground squirrel damage in western Montana. Several possible reasons for this are listed in the "Special Local Needs" section.

A field study (Appendix D) was conducted during June and July of 1976 to determine whether the available strychnine bait could effectively control Columbian ground squirrel populations. In two trials, the strychnine bait yielded 64% and 81% control, while sodium monofluoroacetate yielded 95% and 99% control.

Initially, one might think that 60-80% control is satisfactory and wonder why the need for a more effective bait. There are several reasons for this. First, these tests were conducted under ideal conditions of timing, weather, minimal cover and application methods that are not always possible to duplicate in field control operations.

The second factor relates to the time of year that baiting must be done and the reproductive capacity of Columbian ground squirrels. Baiting for Columbian ground squirrels is limited to mid- to late summer due to their foraging habits. They show such a strong preference for succulent green forage during spring and early summer, that baiting may be unsuccessful.

This fact creates two problems. Control may not be undertaken until after most of the damage for that year has already occurred and there is then a population several times larger than the original breeding population. Even if 70% control is achieved at this point, the surviving population may be about the size of that year's original breeding population. This means that there will be no net reduction

in ground squirrel numbers at the time of next year's breeding season, and that the agricultural loss suffered will be about the same as the previous year. For these reasons, it is important to have available a bait that will consistently achieve better than 90% control. This objective cannot be met with strychnine baits presently registered.

11. Combined Alternatives: Although the alternatives listed above when used singly and/or jointly have not proven effective in reducing Columbian ground squirrel damage, this does not mean their use should be discontinued if 1080 bait registration is approved. In any effort to reduce or maintain Columbian ground squirrel damage below the economic injury level, all feasible methods which do not cause unreasonable adverse effects on the environment should be considered. These methods must not only be environmentally safe and effective in reducing damage, but also must be economically feasible.

III. CONCLUSION

The problem facing western Montana agricultural producers, plus county and state governments, is the need to reduce agricultural damage caused by the Columbian ground squirrel to below the economic injury level. Recognizing the ecological impact of reducing agricultural losses by this species is very complex, state and federal agencies and the general public must continually strive for solutions which will provide for both human and domestic animal safety, while maintaining environmental quality. Acknowledging that Columbian ground squirrels are resources of inherent interest and value to the people of Montana and our nation, one must also recognize the parallel need and responsibility for conducting damage control programs where said species are causing resource conflict situations.

The Montana Department of Livestock has prepared the enclosed application for registration of 1080 grain bait for Columbian ground squirrel damage control recognizing the following facts:

1. A significant Columbian ground squirrel damage problem exists in western Montana.

2. Current management practices and control methods used singly and/or jointly have not proven effective in reducing and/or preventing agricultural resource losses to Columbian ground squirrels.

3. Agricultural damage caused by Columbian ground squirrels was significantly reduced in nearly all areas of western Montana between 1948 and 1971 when 1080 grain bait was used for damage prevention.

4. No human fatalities or accidents occurred while 1080 grain bait was employed during the 24-year time period.

5. The U.S. Environmental Protection Agency has indicated there is no validated field evidence that 1080 baits used for rodent control have resulted in significant population reduction of non-target species or deaths to members of endangered species.

6. The only viable alternative for prevention and/or reduction of agricultural resource losses caused by Columbian ground squirrel populations is the use of 1080 grain bait by trained, licensed state and county government pesticide applicators.

7. The use of 1080 grain baits for Columbian ground squirrel damage control will not adversely effect the environment. There will be no detrimental effects on humans or their immediate environment. Sodium monofluoroacetate (1080) grain baits will be used with such care and under such rigid use restrictions that any significant adverse environmental effects are extremely unlikely.

This registration application has been prepared in conformance with the "Special Local Need" provision, Section 24(C), FIFRA as amended, recognizing there is no EPA registered pesticide product which, under the conditions of use within the State, would be as safe and/or as efficacious for such use within the terms and conditions of EPA registration, and an appropriate EPA registered pesticide product is not available. The Department of Livestock requests immediate approval of this application for registration to meet the needs of western Montana's farmers and ranchers.

IV. APPENDICES

APPENDIX A

RODENT DAMAGE AND CONTROL SURVEY OF 50 MONTANA COUNTIES, 1973

SUMMARY

RODENTICIDE QUESTIONNAIRE OF AUGUST, 1973

Returns from the 50 Counties
County that answered Questionnaire

Date of Meeting _____

Name of Committee RAD, CRD etc.

Chairman of Committee _____ _____
(Name) (Phone)

PLEASE LIST NAMES, TITLES & PHONE NUMBERS OF THOSE PRESENT ON BACK OF THIS PAGE.

QUESTIONS

1. Do the considerations of human health and/or economics require continued control of certain rodent species by rodenticides in your county?

☑ 50 Yes ☐ No

2. If you answered question one "yes", please list below, for this calendar year, the type of damage and estimated economic loss in dollars or human health concerns for each rodent species requiring control in your county. Examples of some types of economic and public health damage to be considered are:

Public Health Examples

Plague
Bitings
Direct Contact
Disease (specify)

Sanitation
Other (specify)

Economic Damage Examples

Forage Crops
Irrigated Lands
Orchards
Pasture Lands
Reforestation
Tree Farms
Crop Lands
Shelterbelts
Other (specify)

Check or fill in the columns

Rodent (44 Counties answered question)		Type of Damage	Economic Loss in Dollars	Public Health Concern
Columbian Ground Squirrel	( )		$1,218,500	
Richardson Ground Squirrel	( )		$4,708,710	
Prairie Dog	( )		$ 718,400	
Pocket Gopher	( )		$2,392,500	
Armatus Ground Squirrel	( )			
Norway Rat	( )		$ 66,000	
Mice	( )		$ 543,028	
Others (list names)	( )		$ 360,810	
	( )			
	( )			
		TOTAL	$10,007,948	

3. Does the present use of rodenticides cause any substantial danger through secondary poisoning to non-target species?

/3/ Yes /47/ No

If "yes", please explain: The three counties which marked "yes" indicated a possibility of secondary poisoning may occur to a few birds by eating target species.

4. Does the present use of rodenticides in your county pose an environmental threat of extinction to certain endangered and target species?

/ / Yes /50/ No

If "yes", please explain:

5. Are you aware of any alternative methods for the control of rodents in your county other than rodenticides?

/19/ Yes /31/ No

If "yes", please explain: Other methods of control mentioned were trapping and shooting.

6. Do you believe the use of rodenticides in general can be sufficiently restricted and controlled to render them environmentally safe to a high degree, but still effective on target species?

/43/ Yes /7/ No

If "no", please explain: Rodenticides could possibly be effective to a high degree and still environmentally safe depending on what type of restriction and control measures might be taken.

7. Has a confirmed sighting of a black-footed ferret been made in your county during the last twenty years?

/4/ Yes /46/ No

If "yes", please give month and year, location, and name of individual reporting sighting. These sightings were checked into by the Department of Livestock and none were found to be confirmed.

8. Check the rodenticide(s) listed below which you feel should be registered for usage by farmers, ranchers, and rural constituents for rodent control in your county:

29 Calcium cyanide (Control of mice, moles, rats, and woodchucks)

49 Strychnine (Control of porcupines, prairie dogs, rats, ground squirrels, moles, pocket gophers, mice, jack rabbits, English sparrows, pigeons, and chipmunks)

19 Sodium monofluoroacetate (1080) (Control of ground squirrels, mice, pocket gophers, prairie dogs, and rats)

18 Sodium cyanide (Control of rats and mice)

The numbers preceding the various rodenticides in Question No. 8 and 9 indicate the number of counties that checked each one.

9. Check the rodenticide(s) listed below which you feel should be registered for usage only by state and/or federal agencies for rodent control in your county:

__8__ Calcium cyanide

__2__ Strychnine

__33__ Sodium monofluoroacetate (1080)

__10__ Sodium cyanide

10. If the rodenticide(s) you recommended for usage by farmers, ranchers, and rural constituents were usable only under certain controls, what controls would you prefer? Please list your order of preference from 1 to 5, with number 1 being your most preferred choice. (NOTE: The proposals listed below would not necessarily operate in the same manner as the Bureau of Sport Fisheries and Wildlife's program which requires approval prior to purchase.)

Preferred as

No. 3 __27__ Qualification by written examination and purchase permit system through a licensed pesticide dealer.

No. 1 __26__ Complete an information request sheet and sign for the bait.

No. 2 __25__ Read specific pamphlets on rodents and species identification and sigh an use agreement.

No. 5 __24__ Rodenticides available only to be used by state or federal personnel.

No. 4 __20__ Rodenticides available only to licensed commercial pesticide applicators specifically licensed for vertebrate pest control.

(No. 1) __7__ Other: (Please be SPECIFIC)

11. In reference to the Notice of Hearing on Certain Rodenticides (Federal Register, Vol. 38, No. 122 - Tuesday, June 26, 1973) please make any written comments in the space provided below, or contact Kenneth Seyler, Department of Livestock, Helena, Montana 59601 - Phone 449-2045.

Written Comments:

ECONOMIC LOSS DUE TO RODENTS - 44 Counties - RODENTICIDE QUESTIONNAIRE - AUGUST 1973

Form 4256 Counties

State Publishing Co
Helena, Montana

	COLUMBIAN GR.SQUIRREL	RICHARDSON GR.SQUIRREL	PRAIRIE DOG	POCKET GOPHER	NORWAY RAT	MICE	OTHERS	TOTAL
Beaverhead	10,000	10,000		10,000		14,000		44,000
Big Horn			15,000	9,000		4,000		28,000
Blaine	NOT FILLED OUT RIGHT							
Broadwater		5,850		200		2,148		8,198
Carbon	NOT FILLED OUT RIGHT							
Carter	SEE FALLON COUNTY - TOTALS FOR BOTH COUNTIES ARE COMBINED							
Cascade		39,800		123,800		8,780	310	172,690
Chouteau		50,000	30,000	15,000		10,000		105,000
Custer			78,000	98,000		11,000		187,000
Daniels		109,400			50,000	70,000	10,500	239,900
Dawson	NOT IN YET							
Deer Lodge -POWELL	187,500	187,500		1,500				376,500
Fallon - CARTER			3,000			25,000	20,000	48,000
Fergus	30,000	100,000	20,000	50,000				200,000
Flathead	200,000			20,000				220,000
Gallatin		75,000				5,000		80,000
Garfield	NOT IN YET							
Glacier		70,000		70,000				140,000
Golden Valley	SEE MUSSELSHELL COUNTY- TOTALS FOR BOTH COUNTIES ARE COMBINED							
Granite	NOT FILLED OUT RIGHT							
Hill	LOST							
Jefferson	SEE MADISON COUNTY - TOTALS FOR BOTH COUNTIES ARE COMBINED							
Judith Basin	250,000		100,000	200,000				550,000
Lake	10,000			6,000		6,000		22,000
Lewis and Clark	75,000	75,000		12,000			10,000	172,000
Liberty		15,500	2,000	4,000		5,000		26,500
Lincoln	10,000			5,000				15,000
Madison - JEFFERSON	50,000	50,000		50,000				150,000
McCone	NOT FILLED OUT RIGHT							
Meagher		60,000						60,000
Mineral	62,500			75,000		3,000		140,500
Missoula	97,500			160,000				257,500
Musselshell - G.Valley		12,500	8,000	30,000		2,000		52,500
Park	5,000	30,000		5,000		20,000		60,000
Petroleum			5,000					5,000
Phillips	NOT FILLED OUT RIGHT							
Pondera		178,000		2,000		18,000		198,000
Powder River			90,000					90,000
Powell	SEE DEER LODGE COUNTY - TOTALS FOR BOTH COUNTIES ARE COMBINED							
Prairie	NOT IN YET							
Ravalli	150,000			150,000				300,000
Richland		56,000						56,000
Roosevelt		80,000		20,000				100,000
Rosebud - TREASURE			15,000	7,000				22,000
Sanders	6,000			10,000				16,000
Sheridan		34,700			5,000	7,000		46,700
Silver Bow	NOT IN YET							
Stillwater		1,000	5,000	10,000	8,000	12,100		36,100
Sweet Grass		600,000	75,000	1,000,000		200,000	320,000	2,195,000
Teton	75,000	1,400,000		6,000	3,000	7,000		1,491,000
Toole		154,960						154,960
Treasure	SEE ROSEBUD COUNTY - TOTALS FOR BOTH COUNTIES ARE COMBINED							
Valley		1,313,500				88,000		1,401,500
Wheatland	NO COUNTY AGENT							
Wibaux	NOT FILLED OUT RIGHT							
Yellowstone			272,400	243,000		25,000		540,400
	$1,218,500	$4,708,710	$ 718,400	$2,392,500	$ 66,000	$ 543,028	$360,810	$10,007,948

APPENDIX B

FINAL REPORT OF THE ADVISORY COUNCIL

ON RODENT AND RABID SKUNK CONTROL

September 1973

(Included only with original application to the U.S. Environmental Protection Agency. Contact Montana Department of Livestock, Helena, Montana for further information.)

APPENDIX C

HOUSE BILL NO. 404

MONTANA SESSION LAWS 1975

UNITED STATES OF AMERICA,)
State of Montana) ss.

I, FRANK MURRAY, Secretary of State of the State of Montana, do hereby certify that the following is a true and correct copy of HOUSE Bill No. 404, Chapter No. 242, Montana Session Laws of 1975, enacted by the Forty-fourth Legislature of the State of Montana, approved by Thomas L. Judge, Governor of said State, on the third day of April, 1975, and effective immediately.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the great Seal of said State.

Done at the City of Helena, the Capital of said State, this ninth day of April, 1975.

Frank Murray

Frank Murray
Secretary of State

. . . . . .

CHAPTER NO. 242
MONTANA SESSION LAWS 1975
HOUSE BILL NO. 404

AN ACT TO AMEND SECTIONS 3-2701 AND 16-1175, R.C.M. 1947, TO PERMIT THE DEPARTMENT OF LIVESTOCK AND COUNTIES TO OPERATE RODENT CONTROL PROGRAMS INDEPENDENT OF THE BUREAU OF SPORTS FISHERIES AND WILDLIFE OF THE DEPARTMENT OF INTERIOR; AND PROVIDING AN IMMEDIATE EFFECTIVE DATE.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MONTANA:

Section 1. Section 3-2701, R.C.M. 1947, is amended to read as follows:

"3-2701. Department of livestock to operate rodent control program. The department of livestock may establish and operate organized and systematic programs for the control and suppression of jack rabbits, prairie dogs, ground squirrels, pocket gophers, rats, mice, and other rodents and related animals in this state when they are injurious to agriculture, other industries, and the public health. For this purpose, the department of livestock may enter into written agreements with appropriate federal agencies, other state agencies, counties, associations, corporations, or individuals covering the methods and procedures to be followed in the control and suppression of these noxious rodents and related animals, the extent of supervision to be exercised by the department of livestock, and the use and expenditure of funds appropriated, when this co-operation is necessary to promote the control and suppression of noxious rodents and related animals."

Section 2. Section 16-1175, R.C.M. 1947, is amended to read as follows:

"16-1175. Control of noxious rodents -- co-operation. The boards of county commissioners shall co-operate with the department of livestock in the control and suppression of noxious rodents and related animals, such as jackrabbits, prairie dogs, ground squirrels, pocket gophers, rats, mice, and other rodents and related animals when they are injurious to agriculture, other industries, and the public health in accordance with organized and systematic plans of the department of livestock covering the methods and procedures to be followed in the control and suppression of these noxious rodents and related animals. For this purpose the boards of county commissioners shall enter into written agreements with the department of livestock covering the methods

and procedures to be followed in the control and suppression of these noxious rodents and related animals, the extent of supervision to be exercised by the board of county commissioners, and the use and expenditures of funds appropriated. The boards of county commissioners, in co-operation with the department of livestock may enter into co-operative agreements with state and federal governmental agencies, counties, associations, corporations, or individuals when co-operation is necessary to promote the control and suppression of noxious rodents and related animals."

Section 3. This act is effective on passage and approval.

APPENDIX D

A FIELD EVALUATION OF STRYCHNINE AND SODIUM MONOFLUOROACETATE (1080) GRAIN BAITS FOR COLUMBIAN GROUND SQUIRREL CONTROL IN WESTERN MONTANA, 1976

A FIELD EVALUATION OF STRYCHNINE AND SODIUM MONOFLUOROACETATE (COMPOUND 1080) GRAIN BAITS FOR COLUMBIAN GROUND SQUIRREL (Spermophilus columbianus) CONTROL IN MONTANA

by
Ray Record
Western District Biologist
Vertebrate Pest Control Bureau
Montana Department of Livestock
December, 1976

ABSTRACT

Bait efficacy trials for Columbian ground squirrel control were conducted in Powell and Flathead Counties during June and July, 1976, by the Montana Department of Livestock. Ground squirrel numbers were reduced 64% using 0.5% strychnine on steam-rolled oat groats, 68% and 81% using 0.5% strychnine on crimped ("Pocatello") oats, and 95% and 99% using Compound 1080 on steam-rolled oat groats.

INTRODUCTION

The Columbian ground squirrel is common in much of western Montana from the east slope of the Continental Divide westward. They pose a serious pest problem in many areas by competing with livestock for forage, destroying food crops, and serving as a potential disease reservoir. Therefore, it is desirable to manage local population levels when necessary to reduce economic damage and human health hazard.

The U.S. Fish and Wildlife Service conducted a successful control program from 1948 to 1971. Grain baits treated with sodium monofluoroacetate (1080) were used. In 1964, the U.S. Fish and Wildlife Service began reducing its rodent control activities to a program of selling strychnine grain bait to the counties for local distribution. Few farmers report achieving satisfactory control using strychnine grain baits on an individual basis (Record, 1976).

Studies were initiated in Powell and Flathead Counties to determine the efficacy of strychnine and Compound 1080 for Columbian ground squirrel control. Efficacy means having the ability to produce the desired effect. The desired effect in this case is the reduction of Columbian ground squirrel numbers to a point below the economic injury level.[1]

OBJECTIVES

Field evaluations were conducted to determine the relative efficacy and non-target species hazard of strychnine and sodium monofluoroacetate (1080) grain baits for controlling Columbian ground squirrels.

MATERIALS AND METHODS

Bait Efficacy

The sites chosen for the tests were non-irrigated pastureland where ground squirrel populations were moderately high. The Powell County area was divided into four test sites of approximately ten acres each. Ground squirrel activity was monitored by visual observation at each of the four sites for three days before, and three days after treatment. Three counts were made at the same times each day. The average of the nine counts made before treatment, and the average of the nine counts made after treatment provided, respectively, the pre- and post-treatment activity indexes.

The two test sites in Flathead County were approximately 20 acres each. Due to time limitations, ground squirrel activity was monitored two days before and two days after treatment. Three counts were made each day. The average of the six counts made before, and the average

[1] Economic injury level is reached when damage to agriculture resources exceeds the cost of reducing or preventing the damage.

of the six made after treatment provided, respectively, the pre- and post-treatment activity indexes.

Non-Target Species Hazard

A small mammal population survey was conducted at each of the four Powell County test sites. Thirty Victor mouse snap-traps and ten Sherman live-traps were set on each site and baited with peanut butter to determine the presence of small mammals. Trapping was conducted for three days before, and three days after treatment. The species, age and sex of animals trapped were recorded. Those caught in Sherman live-traps were eartagged and released. Each site was searched following treatment, and any dead small mammals observed were autopsied and the findings were recorded.

Carnivores observed before and after treatment at each site were noted. After treatment, each site was thoroughly searched for dead carnivores.

Species of birds seen on the test site before and after treatment were recorded. After treatment, each site was thoroughly searched for dead birds which may have succumbed to the baits.

Baiting

Bait was applied equally at each site. One tablespoon was scattered near each active entrance to a ground squirrel burrow. The baits used at the test sites were as follows:

Powell County

Site # 1	0.05% 1080 on steam-rolled oat groats
Site # 2	0.5% strychnine on steam-rolled oat groats
Site # 3	No bait - non-treatment area

Powell County (Cont'd)

Site # 4 0.5% strychnine on crimped "Pocatello" oats

Flathead County

Site # 1 0.5% strychnine on crimped "Pocatello" oats

Site # 2 0.05% 1080 on steam-rolled oat groats

Bait efficacy was determined by calculating the percentage of ground squirrel control for each site by the following method:

$$\text{Percentage control} = 1 - \left(\frac{\text{3-day post-treatment activity index}}{\text{3-day pre-treatment activity index}} \right) \times 100$$

RESULTS

Bait Efficacy

Weather conditions remained generally stable during the tests. A brief rain shower occurred after the bait was placed in the Powell County experiment, but the amount was not sufficient to significantly disturb the bait.

The temperature was noticeably lower and a wind of about 15 mph was blowing the second day of visual observation at the Powell County test sites. This probably accounts for the lower activity index for that day.

Results of the pre- and post-treatment ground squirrel counts are listed in Table I (Powell County) and Table II (Flathead County) with the corresponding bait applied on each site. Efficacy or control measured as percent reduction in ground squirrel activity, is shown on the next page.

Powell County

Site # 1	0.05% 1080 on oat groats.....	95% control
Site # 2	0.5% strychnine on oat groats.....	64% control
Site # 3	No bait applied.....	3% reduction in activity
Site # 4	0.5% strychnine on crimped oats.....	68% control

Flathead County

Site # 1	0.5% strychnine on crimped oats.....	81% control
Site # 2	0.05% 1080 on oat groats.....	99% control

Non-Target Species Hazard

Small mammals trapped on each of the Powell County test sites are listed in Table III. The results shown in Table III indicate Peromyscus maniculatus populations may be reduced locally by ground squirrel control with any of the baits tested. The sample sizes are quite small, however, and no broad generalizations should be made from these data.

Several small mammals were found dead during the post-treatment search of the test sites. Four dead ground squirrels were found on top of the ground on Site #1. They all had yellow dye in the lower region of their stomachs and upper regions of their small intestines. The 1080 bait was dyed yellow.

One dead Peromyscus maniculatus was found on top of the ground on Site #2. Green dye was found in the upper region of its stomach. The strychnine on oat groat formula was dyed green.

One juvenile Peromyscus maniculatus was found on Site #4. No dye was found in its gastro-intestinal tract. The strychnine on crimped oat formula was not dyed.

One partially paralyzed ground squirrel was also observed on Site #4.

Three days following treatment, a badger was observed digging on Site #2.

DISCUSSION

The 1080 grain bait was more effective than the strychnine grain bait in controlling ground squirrels in these field evaluations. These findings agree with the opinions expressed by U.S. Fish and Wildlife Service personnel who conducted control programs in western Montana utilizing the two toxicants (Bateman, 1946; Beebe, 1947; Grand, 1948).

A possible explanation of the difference in control success may be strychnine's strong, bitter flavor and short time between ingestion and onset of symptoms (latent period). This allows squirrels to become ill before a lethal dose has been consumed. They may identify their illness with the bitter-tasting grain and refuse to eat additional bait. This phenomenon is known as "poison or bait shyness". Compound 1080 is essentially tasteless and has a relatively long latent period, reducing the possibility of bait shyness.

The difference between the two baits is actually greater than the percent control figures would indicate. It will take a very short period of time for ground squirrel populations to return to high levels where 20 to 40 percent of the population survives a baiting operation. Control operations will probably be necessary in these areas the following year. Ninety percent reduction is considered the minimum level of control necessary (Klaustermeyer and McGlothlen, undated). Where a high degree of control is achieved,

baiting may not be necessary again for two to three years. This reduces the damage by the ground squirrels, but also decreases the amount of toxic bait used within this two to three year period.

It is significant that no dead birds were found on the test sites. This does not assure, however, that no birds were killed. Larks, killdeers, and curlews were seen on the area both before and after treatment. The use of large grains, altering grain shapes, and dyeing the grain all serve to decrease the potential hazard to birds.

TABLE I

GROUND SQUIRREL ACTIVITY INDEXES[1]

POWELL COUNTY

	Site 1	Site 2	Site 3	Site 4
Pre-treatment				
June 30	28.7	22.3	15.3	24.7
July 1	11.7	5.0	6.7	15.0
July 2	17.7	12.3	13.3	21.0
Average[2]	19.4	13.2	11.8	20.2
Bait Applied July 7	0.05% 1080 on steam-rolled oat groats	0.5% Strychnine on steam-rolled oat groats	No treatment	0.5% Strychnine on crimped oats
Post-treatment				
July 8	2.6	4.7	11.3	5.3
July 9	0.0	5.0	11.3	6.7
July 10	0.0	4.7	11.7	7.3
Average	0.9	4.8	11.4	6.4

[1]Each day's activity index is an average of three counts.

[2]Activity Index is average of nine total counts.

TABLE II

GROUND SQUIRREL ACTIVITY INDEXES[1]

FLATHEAD COUNTY

	Site 1	Site 2
Pre-treatment		
July 17	71.6	90.7
July 18	84.4	120.9
Average[2]	78.0	105.8
Bait Applied July 20	0.5% Strychnine on crimped oats	0.05% 1080 on steam-rolled oat groats
Post-treatment		
July 21	9.0	1.3
July 22	20.0	0.0
Average	14.5	0.7

[1]Each day's activity index is an average of two counts.

[2]Activity index is average of six total counts.

TABLE III

SMALL MAMMAL SURVEY DATA

	PRE-TREATMENT YIELD (150 trap-nights/site)	POST-TREATMENT YIELD (150 trap-nights/site)
Site 1	Peromyscus maniculatus 3 Adult Males 2 Adult Females 1 Juvenile Male	None
Site 2	Peromyscus maniculatus 2 Adult Males 2 Juvenile Males	None
Site 3	Peromyscus maniculatus ? Adult Males	Peromyscus maniculatus 1 Adult Male 3 Adult Females
Site 4	Peromyscus maniculatus 3 Adult Females	Peromyscus maniculatus 1 Adult Male

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APPENDIX E

LD_{50}'s OF SODIUM MONOFLUOROACETATE

1971

from "A Review of Sodium Monofluoroacetate (Compound 1080)"

by Stephen P. Atzert

TABLE 2. LD_{50}'s of sodium monofluoroacetate.

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
MAMMALS				
Primates				
Man	0.7-2.1	Estimated	Oral	1,2
Rhesus monkey (Macaca mulatta)	4.0		I.V.	3
Spider monkey (Ateles geoffroyi)	15.0		I.V.	3
Ungulates				
Cow				
adults(F)	0.393	0.247-0.625	Oral	4
juvenile (M-F)	0.221	0.149-0.327	Oral	4
Goat	0.6		I.M.	3
Horse (M-F)	0.35-0.55		Oral	5
Mule (M-F)	0.22-0.44		Oral	5
Mule Deer (Odocoileus h. hemionus) M-F	0.30-1.00		Oral	5
Sheep (M-F)	0.25-0.50		Oral	6
Swine				
adult	<1.0		Oral	3
young	0.4		Oral	3
Carnivores				
Bear (Ursus sp.)	0.5-1.0		Oral	7

TABLE 2--continued

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
Bobcat (Lynx rufus baileyi)	0.66		I.P.	8
Domestic cat	0.20		I.V.	8
Coyote (Canis latrans nebracensis)	0.10		I.V.	8
Grey Fox (Urocyon cinereoargenteus scotti)	0.3		I.P.	8
Badger (Taxidea taxus berlandieri)	1.0-1.5		I.P.	8
Domestic ferret (Mustela putorious)	1.41		Oral (S.T.)	5
Marten (Martes americana)	1.0		Oral	7
Mink (Mustela vison)	1.0		Oral	7
Rodents				
Ground Squirrels:				
Columbia (Citellus c. columbianus)	0.9		I.P.	3
Fisher's (Citellus beecheyi fisheri)	0.3		Oral	3
Pocket Gophers:				
Breviceps (Geomys breviceps sp.)	0.05		I.P.	3
Tuza (Geomys floridanus)	0.2		I.P.	3

TABLE 2--continued

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
Kangaroo Rats:				
Bannertail (Dipodomys s. spectabilis)	0.1		I.P.	8
Merriam (Dipodomys m. merriami)	0.15		I.P.	3
Rats:				
Norway-lab (Rattus norvegicus) M	2.1		Oral	9
F	2.2		Oral	9
Alexandrine (Rattus rattus alexandricus)	0.5		Oral	3
Black (Rattus rattus sp.)	0.1		Oral	3
Cotton (Sigmodon hispidus litteralis)	0.1		Oral	8
Norway-wild (Rattus norvegicus)	3.0		Oral	3
White-throated wood (Neotoma a. albigula)	< 0.8		I.P.	8
Wood (Neotoma intermedia)	1.5		Oral	3
Mice:				
Deer mouse (Peromyscus sp.)	4.0		Oral	8
House mouse (Mus musculus)	8.0		Oral	3
Miscellaneous spp:				
Meadow vole (Microtus pennsylvanicus)	0.92		Oral	9

TABLE 2--continued

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
Nutria (Myocastor coypus)	0.056		Oral	9
Porcupine (Erethizon dorsatum)	<1.0		I.P.	8
Prairie Dog (Cynomys ludovicianus)	0.3		Oral (S.T.)	8
Lagomorphs				
Black-tailed jack rabbit (Lepus californicus)	5.55		Oral	9
European Rabbit (Oryctolagus cuniculus)	<0.8		Oral	10
BIRDS				
Columbiformes				
Domestic pigeon (Columba livia)(M-F)	4.24	3.36-5.34	Oral	5
Mourning Dove (Zenaidura macroura) (M-F)	8.55-14.6		Oral (S.T.)	5
Anseriformes				
Mallard (Anas p. platyrhynchos)				
adult (M)	10.0		Oral (S.T.)	5
adult (F)	8.0		Oral (S.T.)	5
Pintail (Anas acuta tzitzihoa)				
adult (M)	10.0		Oral (S.T.)	8
adult (F)	8.0		Oral (S.T.)	8

TABLE 2--continued

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
Galliformes				
Chicken	7.5		Oral	3
Chukar (Alectoris graeca) (M-F)	3.51	2.58-4.78	Oral	5
Gambels quail (Lophortyx gambeli)	20		Oral	3
Japanese Quail (Coturnix coturnix japonica) (M)	17.7	11.0-28.7	Oral	
Ring-necked pheasant (Phasianus colchicus) (M)	6.46	3.85-10.8	Oral	5
Turkey (Maleagris galiopavo) (F)	4.00	1.20-13.3	Oral	5
Passerines				
Brewer's blackbird (Euphagus cyanocephalus)	2.0-3.0		Oral	8
English Sparrow (Passer domesticus) (M)	3.00	2.38-3.78	Oral	5
Magpie (Pica p. hudsonia)	0.6-1.3		Oral	8
Raptors and Scavengers				
Golden eagle (Aquila chrysaetos canadensis)	1.25-5.00		Oral	5
American rough-legged hawk (Buteo lagopus sancti-johannis)	~10.0**		Oral	8

TABLE 2--continued

Species	LD_{50}* mg/kg	95% Confidence Interval	Route of Administration	Reference
Ferruginous rough-legged hawk (Buteo regalis)	~10.0**		Oral	8
Marsh hawk (Circus cyaneus hudsonius)	~10.0**		Oral	8
Great Horned Owl (Bubo virginianus pallescens)	~10.0**		Oral	8
Black vulture (Coragyps atratus)	15.0		Oral	8
Turkey vulture (Cathartes aura)	< 20.0		Oral (S.T.)	8
AMPHIBIANS				
Bull Frog (Rana catesbeiana) (M)	54.4	25.6-115	Oral	5
Leopard Frog (Rana pipiens)	150.0		S.C.	3
South African Clawed toad (Xenopis laevis)	> 500.0		I.P. S.C.	3

FOOTNOTES TO TABLE 2:

1. Kaye (1970)
2. Arena (1970)
3. Chenoweth (1949)
4. Robison (1970)
5. Tucker and Crabtree (1970)
6. Jensen *et al.* (1948)
7. Robinson (1953)
8. Ward and Spencer (1947)
9. Denver Wildlife Research Center (Unpublished)
10. Lazarus (1956)

* Where confidence limits are not provided the figure is assumed to be an observed non-statistical estimate.

** Vomiting characteristic and early symptom.

M Male

F Female

I.V. Intravenous

I.M. Intramuscular

I.P. Intraperitoneal

S.T. Stomach Tube

S.C. Subcutaneous

< Less than

> Greater than

~ Approximately

APPENDIX F

GROUND SQUIRREL CONTROL IN CALIFORNIA

1962

from "Proceedings Vertebrate Pest Control Conference,"

Sacramento, California

GROUND SQUIRREL CONTROL IN CALIFORNIA

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The control of ground squirrels in California is important in two ways. First, it is necessary to prevent destruction of agricultural crops. Second, it is important from a health standpoint where rodent-borne diseases have been demonstrated to be present. Ground squirrel control in this State is the responsibility of the county agricultural commissioners, the State Department of Agriculture and on Federal lands the Bureau of Sport Fisheries and Wildlife. Most control measures are concerned with but two of the nine species of ground squirrels found in California. These include four subspecies: Beechey ground squirrel (Citellus beecheyi beecheyi), Douglas ground squirrel (Citellus beecheyi douglasii), Fisher ground squirrel (Citellus beecheyi fisheri), and Oregon ground squirrel (Citellus oregonus).

The more aggressive species, the Beecheyi ground squirrel, is found along coastal California from the Golden Gate and Carquinez Straits south nearly to San Diego; the Fisher ground squirrel inhabits the greater part of central California east of the Feather and Sacramento Rivers south to the southern end of the San Joaquin Valley.

The Douglas ground squirrel occurs northward from San Francisco Bay throughout the region west and north of the Sacramento and Feather Rivers extending north to the Oregon line. The smaller short-tailed Oregon ground squirrel inhabits the northeastern plateau counties of Modoc, Lassen, Siskiyou and Plumas.

Ground squirrels have enormous "comeback" powers. So long as an adequate food supply is available, their annual litters will average about 6 to 8 young; therefore, a few years of neglect by the growers may create new centers of population which will reinfest clean areas.

A natural habit characteristic of Beechey ground squirrels is hibernation. The squirrels go through non-specific periods of dormancy in the winter months, and during certain periods of drought and extremely hot weather they go through a period of aestivation, or "summer sleep," all of which complicates control procedure. Too often after control measures have been applied, ground squirrels later appear on the treated area because some had been dormant at the time control was done.

There are several essential steps to consider before control is undertaken. The arbitrary selection of a grain bait is not satisfactory. Field test plots using several kinds of clean bait must be put out in small piles on bare ground to determine bait preference. The piles of bait should not be placed in or directly in front of the burrows. The selection of the grain bait to be used is made only after exposure of two or more kinds of untreated grain.

It is also necessary to determine the period of maximum squirrel activity if optimum results are to be achieved. One period of high activity occurs during the breeding season. To accurately define this period, which varies with geographic and climatic conditions as well as with species, it is necessary to shoot a number of squirrels to determine sex ratio. As the breeding period nears, the ratio of males to females tends to equalize, and this is considered by some authorities as the period of maximum activity. Prior to this period males will predominate and, when the sex ratio is mostly males, it is too early to start control operations. Shooting or trapping is continued into the period during which embryo counts can be made. From these examinations of the embryo, it is possible to fix with reasonable accuracy the time the work must be curtailed as well as determining when it may be resumed.

The next step is to conduct bait acceptance tests to make sure the squirrels continue to take the preferred bait after it has been treated with a toxicant. For this purpose a pre-determined area on which the approximate number of squirrels

is known is selected. The area must be a new one to avoid testing with squirrels that have been prebaited as a result of the bait preference tests. In no case is the same area used for both purposes. In acceptance tests the bait is scattered in the same manner as is done in normal control procedure. If bait acceptance is satisfactory and resulting kill is determined to be satisfactory, control measures should be started immediately.

The amount of treated bait used is highly important from an economic as well as conservation standpoint. A residue of about 10 percent of the original bait following a 24-hour exposure period is a good yardstick. Underbaiting results in poor control, whereas overbaiting creates unnecessary hazards. Once less than satisfactory results are duplicated it may be necessary to allow a rest period during which no grain baits are used.

The ultimate success of any rodent control program is entirely dependent on the effort expended by the person in charge of the job. It is essential that all phases of field work be carefully observed so that any changes in daily rodent activity, bait acceptance and degree of kill will be noted. The comprehension of these factors will result in a high degree of efficiency and ultimately a more effective and economical control program.

POISON BAITS

1080. It is common practice with sodium fluoroacetate (1080), which has proven to be the most effective toxicant for the control of ground squirrels, to treat where possible only once every two or three years to maintain a continuously reduced population. This infrequent baiting is desirable as too frequent application of bait may bring about bait and poison shyness.

There is generally a period of four to six weeks during the breeding season when excellent results may be obtained. Control operations carried on during the breeding season are occasionally hampered due to work stoppage when unfavorable

weather conditions occur.

Control work must be stopped as soon as the young become old enough to survive without adults and should not be resumed until the young appear above ground and are large enough to take bait. Then there should be no further interruptions until inspection determines a slowdown of activity indicating aestivation. This normally can be expected following a few days of hot weather. Aestivation may continue on into the winter hibernation in some areas. These dormant periods may be continuous or interrupted with different individuals. In some areas there may be a brief period of high activity in October and November when effective control measures may be applied.

Most rodenticides are toxic to wildlife if ingested in sufficient amounts. Protection of birds has been achieved by coloring grain baits and using feed grains that birds tend to reject. Modification of the natural kernel shape serves to make the grain less attractive to birds. These deterrents, together with good judgment in timing, do much to hold accidental mortality among birds to a minimum. The use of 1080 and Thallium sulfate in California is restricted to qualified persons according to law. Section 1080.5 and 1080.6 of the California Agricultural Code is the authority.

Sometimes there is a marked difference in effectiveness of a poison with different sub-species. For example, the Douglas ground squirrel of northern California is easy to control with strychnine, while in the area south of San Francisco Bay the closely related Beechey ground squirrel is difficult to control with strychnine baits.

Strychnine. The success of poisoning with strychnine-coated grain is due largely to a squirrel's habit of gathering seeds and carrying them home in its cheek pouches during the dry season. The cheek pouches are muscular sacs within the mouth, each large enough to hold about 250 kernels of barley. Much of the food

carried in the cheek pouches is not eaten at the time, but taken for winter use to underground storehouses or cached near the burrow entrance. When grain coated with a properly prepared strychnine solution is carried in the pouches, enough of the poison is dissolved and absorbed to quickly kill the animal. In 1909 S. E. Piper of the United States Bureau of Biological Survey made the important discovery that strychnine is far more quickly absorbed by the cheek pouches than by the stomach; he found that one-fifth the quantity necessary to kill by the stomach will kill when taken into the pouches (Merriam, 1910). The rapidity in which the coated grain takes effect is demonstrated by the large percentage of squirrels that are overcome by the poison while still engaged in gathering the scattered kernels and die before entering their burrows.

After the start of the rainy season when natural green feeds become available to squirrels, pouching ceases and strychnine grain is no longer effective. This led to recognition of the necessity to find some other poison which would be effective at this time of the year. During the green feed period, it may be necessary to use a stomach poison such as 1080 or thallium since the squirrels will not normally be pouching. This is one exception to this as occasionally Douglas squirrels will continue pouching baits after green feed has appeared.

Thallium Sulfate. In 1926, thallium sulfate was introduced from Europe (Piper and Jacobsen, 1944). "This material was first used extensively in California against field rodents after trials proved it to be effective during late fall, winter and spring months as a relatively economical stomach poison and a suitable supplement to the strychnine coated grain method." Thallium sulfate is used on potted barley, crushed oats and squirrel oat groats.

Thallium sulfate is taken up during the normal digestive process. It is non-bitter in taste and is slow acting. If a good dose is ingested on the first feeding, the squirrel may be killed in a comparatively short time. However, if

only a minimum lethal dose is taken, it may take several days for death to occur.

Zinc Phosphide. This material was investigated for ground squirrel control during the early 1940's. New techniques were attempted for causing this chemical to adhere to a variety of baits and it showed up surprisingly well in spite of earlier failures when freshly mixed, applied sparingly and used in rotation with other baits. Zinc phosphide is a poison which may kill within thirty minutes, or may allow animals to survive for several days. It may be used over a longer period than strychnine. It is usually applied on squirrel oat groats, crimped oats or whole barley.

Field observations have revealed that squirrels not consuming toxic grain baits would not eat clean grain of any kind. Clean grain has been given at different seasons of the year with the same results. Fortunately the percentage of animals thus rejecting grain is not large. The manner of feeding is also in the animal's favor. Some squirrels feed a little on one food, then on another. Generally, they do not sit by any one particular bait and fill up on it.

To overcome the problem of an aversion to bait or sub-lethal feeding in Oregon ground squirrels, White (1959) demonstrated in Modoc County that control could be achieved by mechanical baiting with a mixture of clean and toxic kernels. Treatments of 3 pounds per acre composed of 30 percent toxic grain (treated at concentration of 5 ounces 1080 per 100 pounds of squirrel oat groats) and mixed with 70 percent clean whole oats gave a higher degree of control than conventional baiting methods employing no clean grain.

Anticoagulants. Anticoagulants have been used in many areas within the State where other rodenticides were considered too hazardous. The exposure of anticoagulant baits is generally done in bait boxes, although some areas are treated by the open bait exposure method. Both methods have resulted in satisfactory control but

labor costs are high.

FUMIGANTS

Carbon Bisulphide. Dr. E. W. Hilgard of the University of California Experiment Station in 1876 first advised the use of carbon bisulphide upon ground squirrels after he had noted that it had been successfully used in France to exterminate rats in sewers.

The types of treatment used included the "waste ball" method, which is still being used in some areas. This method consists of saturating 50 to 60 jute balls (about 2 inches in diameter) in a bucket with a gallon of carbon bisulphide. One ball is thrown deep into each burrow. Immediately after a burrow is treated, the entrance should be closed with a shovelful of earth and quickly tramped to insure air tight sealing.

Another method in the use of carbon bisulphide consists of exploding the gas in the burrow. Carbon bisulphide is extremely inflammable and very explosive and therefore should be used with caution. The common procedure is to place a saturated waste ball in the burrow, seal the entrance with a piece of sod or a loose clod of earth for five to fifteen minutes to allow the gas to vaporize, then remove the clod and apply a small lighted torch consisting of a cloth soaked in kerosene wrapped around a thin piece of pipe. The explosion will be extremely vigorous and has the advantage of indicating whether all the entrances of the burrows have been previously closed. This method should never be employed when the grass is dry as serious fires could result. Also extreme care should be used when lighting the gas in the burrow. This procedure of firing the burrows is often used in orchards with no detrimental effects on the trees.

The first practical pump to vaporize carbon bisulphide in squirrel burrows was developed by Surgeon J. D. Long of the United States Public Health Service. Several types of pumps have been used to force carbon vapors into squirrel burrows.

In recent years the Demon Rodent Gun, a heavy metal cylinder with pump and reservoir for liquid carbon bisulphide, has replaced practically all other types. The pump forces the carbon through a flexible hose and a spray nozzle. The nozzle is placed in the burrow, and the burrow mouth plugged with a shovelful of earth to prevent loss of gas. One stroke of the pump releases one fluid ounce of the carbon bisulphide, most of which will vaporize inside the burrow. After the hose has been withdrawn, the burrow entrance is immediately sealed with dirt or sod in sufficient quantity to make a little mound which should be well tramped and packed to prevent any escape of gas. The treated areas are usually rechecked within a week. All open burrows should be retreated with 2 to 4 ounces of carbon bisulphide.

Complex runways and pockets in burrows, the hibernation of squirrels and the isolation of females are the causes of some of the difficulties attending the use of gas. Another factor that makes the use of gas difficult is the squirrel's habit of "plugging" against an enemy. This simply means the squirrel will plug part of the runway and block off the exit. Squirrels do this against a gas invasion as well as animal enemies. Gases of low toxicity that diffuse slowly through the burrow, such as carbon dioxide and sulphur dioxide, have not proven successful. Carbon monoxide is effective, but so far no practical method of application has been devised. Carbon bisulphide applied with the waste ball method has been quite effective, but there are disadvantages too. For example, it is limited to the wet season; it is slow to convert into a gaseous state, slow to diffuse throughout the burrow and has a slow physiological effect on the animal. All these factors considerably reduce its efficiency. The Demon Rodent Gun has removed some of these objections as it vaporizes the carbon bisulphide in a gaseous state, thereby quickly raising the concentration to a lethal level and preventing the squirrel from escaping so easily.

The general use of carbon bisulphide has been limited to the wet season when the soil is well packed and free of cracks so that the gas will remain in a lethal

concentration for a longer time. This is necessary to ensure a kill as the animal must be in the gas several minutes unless it is at a very high concentration. Stewart and Burd (1918) reported that in a two percent concentration of carbon bisulphide a squirrel partially collapsed in from six to ten minutes and in seventeen to twenty minutes had ceased breathing.

Methyl Bromide. This material has proved to be effective in the control of rodents as well as the insects harbored by them. There is no danger from fire and it can be used in wet or dry soils and at various temperatures. Although the cost is higher than some of the other fumigants, it can be used where follow-up or eradication measures are being carried on and in areas where inflammables or toxic baits are undesirable.

Berry (1938) reported successful results in killing ground squirrels by injecting 10 cc methyl bromide per burrow. The use of one pound cans of methyl bromide and attachable dispensers has replaced many of the larger containers formerly used in ground squirrel control.

A one pound can contains 262 cc's of liquid methyl bromide. Theoretically it should deliver 26 10-cc dosages, but through repeated field use 17 to 20 dosages per pound appear to be average output per can.

Other Fumigants. A common method of controlling small infestations of ground squirrels is the use of the exhaust of an automobile. One end of a hose may be attached to the exhaust pipe and the other end inserted in the burrow. Stewart and Burd (1918) reported "carbon monoxide is poisonous to both animals and human beings if as much as one-tenth of one percent is present in air". The carbon monoxide gas generated by the engine penetrates the burrow and will kill the squirrel quickly. This method is often used in orchards for cleanup work or where only a few ground squirrels remain.

Many fumigants have been tested to find a gas that would be fatal more quickly and at low concentrations. It is also necessary for the gas to be safe to handle with reasonable precautions. Some of the many fumigants which have been tried are hydrocyanic acid gas, calcium cyanide, fumes of sulphur, gasoline, petroleum distillate, chloropicrin, kerosene and tetrachloroethane, some with varying success, but none have come into general use.

TRAPPING

Traps securely tied may be used at any season of the year to remove small local populations of squirrels, or to clean up those that escape poison or gas. The wooden box type gopher trap with certain modifications has been very effective in situations where other control methods are unsuitable.

Traps baited with an English walnut or piece of orange placed near the burrow entrance or tied to limbs of trees have been used successfully, even on fox squirrels. One modification is to replace the back of the trap with two 1/2-inch strips of strap iron stapled to the two sides equal distance between the top of trap and the ground level. A piece of 1/2-inch hardware cloth will also suffice to cover the back. This lights up the interior of the box compartment and allows the bait to be observed from both ends, but still prevents the animal from entering the trap except from the front. Half of the trigger loop is removed, and the bottom of the loop is straightened so that bait is held above the ground level. The trigger holding the spring on top of the trap is modified to release when pulled forward toward the trap front. Live catch traps, consisting of a rectangular cage of hardware cloth with a drop door at either end and central trigger pan in the floor, are extremely effective in catching squirrels. Wire trap 6" x 6" x 19" is the recommended size for catching squirrels.

In trapping squirrels where there are a number to be taken, it is recommended that traps be set with the door open for a few days in the areas where the squirrels

are causing annoyance. The trap can be baited with almonds, walnuts, grain or other bait attractive to squirrels. In the course of a few days, all the squirrels will become completely used to the trap and will pass in and out freely. Then, when the doors are untied, one is able to take squirrels which might otherwise have a tendency to avoid the device.

The steel jump trap No. 0 or 1 placed unbaited and buried flush with the surface near a feeding place or in the burrow entrance is a trapping procedure which has been used for many years. Baiting with this method is done by scattering grain over the traps.

SUMMARY

Poisoning, trapping and fumigating are the only known procedures offering any satisfactory solution to ground squirrel control and, of these, poisoning is usually the best method. Sodium fluoroacetate is the most effective toxicant. Others that have been tried with varied success include strychnine, thallium, zinc phosphide and anticoagulants. The use of carbon bisulphide and methyl bromide as fumigants has proven successful. Contrary to opinion held by some, it is possible with present knowledge of the characteristics of poisons and the habits of animals to select, prepare and expose baits so as not to seriously endanger other forms of wildlife and domestic animals.

BAIT FORMULAS

For Beechey, Fisher and Douglas Ground Squirrels

Sodium Fluroacetate (1080) Formula

Whole Oats (recleaned)	100 pounds
Lecithin-mineral oil (22 ozs. liquid)	2/3 quart
Water	1 quart
Dye (Auramine O Conc. 130%)	½ ounce
Compound 1080 (Sodium fluoroacetate 90%)	1 ounce

Heat the water and add the 1080; stir until dissolved; add the dye and stir; then add the lecithin-mineral oil and stir until you have an emulsion. (Do not boil.) Pour this mixture over bait and mix thoroughly. If bait is to be used in a reasonable time, it can be sacked without drying.

Squirrel oat groats may be used in place of whole oats.

Strychnine Formula

Whole Barley (recleaned)	100 pounds
Strychnine (powdered alkaloid)	5 ounces
Bicarbonate of soda (baking soda)	5 ounces
Saccharin	½ ounce
Heavy corn sirup	20 ounces
Thin starch paste	60 ounces
Glycerin	2½ ounces

Mix thoroughly the powdered strychnine (alkaloid), baking soda and saccharin. Crush all lumps of the soda with mixing spoon. To this add corn sirup and stir thoroughly to a smooth, creamy paste free from lumps. Over this pour thin hot starch paste and stir well. (The starch paste is made by dissolving the dry gloss starch in a little cold water which is then added to the boiling water. Boil and stir constantly until a clear thin paste is formed.) Add glycerin and stir thoroughly, making sure that none of the heavy sirup paste still sticks to the bottom of the container. Pour this mixture over the barley and mix well so that each grain is coated.

For making small quantities an ordinary galvanized wash tub is convenient. For larger quantities a mechanical mixer may be used.

A quart of poisoned grain is sufficient for 40 to 50 baits. This quantity scattered along squirrel trails or on clean, hard places on the surface about the holes will not endanger stock.

N.B.--Strychnine in any form other than the powdered strychnine alkaloid is not effective in the above formula.

Thallium Sulphate Formula No. 1

Special steam-rolled oats	75 lbs.
Thallium sulphate (preferably ball milled)	1 lb.
Gloss or corn starch	10 ozs.
Glycerin	1 Tbs.
Water (hot)	6 qts.

Procedure same as for thallium formula No. 3.

The thallium sulphate is slowly dissolved in the hot water. This amount of water of ordinary purity will dissolve this amount of thallium. Where much impurity is present in the water, it sometimes requires as much as eight quarts of water to dissolve this amount of thallium. In some cases 100 pounds of oats to 1 pound of thallium sulphate have been used, and in cases where acceptance was rapid the results were apparently the same, which reduced the expense for bait material.

Thallium Sulphate Formula No. 2

Oat groats (semi crushed)	100 pounds
Water	1 quart
Lecithin-mineral oil	3/4 quart
Thallium sulfate (200 mesh) (Thallous sulfate 99%)	16 ounces

Mix water on bait first; then mix thallium in the lecithin mineral oil and pour over grain and mix thoroughly.

Thallium Sulphate Formula No. 3

Thallium sulphate	1 lb. (16 oz.)
Hot water	5 qts.
Starch (dry)	6 ozs.
Glycerine	1/3 pt.
Hulled barley	100 lbs.

The thallium sulphate is dissolved in the five quarts of hot water to which is then added the starch, previously mixed with a little cold water which brings it to the consistency of cream; glycerine is then added. It is important that copper or granite ware vessels be used exclusively in the preparation of these

mixtures as there seems to be a chemical reaction with other metals when thallium is in the solution.

Zinc Phosphide Formula No. 1

Whole barley (recleaned)	100 pounds
Lecithin-mineral oil	1 pint
Zinc phosphide (powdered) (Zinc phosphide 90%)	16 ounces

Mix the zinc with lecithin-mineral oil thoroughly; then pour over grain and mix.

Zinc Phosphide Formula No. 2

Oat groats (semi-crushed)	100 pounds
Lecithin-mineral oil (22 ozs. liquid)	2/3 quart
Zinc phosphide (powdered zinc phosphide 90%)	16 ounces

One pound of grain will make 50-60 bait spots.

Anticoagulant Formula

Grain bait	16 pounds
Anticoagulant concentrate (0.5%)	1 pound
Lecithin-mineral oil (warm)	10 to 24 fluid ounces

Thoroughly mix the anticoagulant and the mineral oil; pour over grain and stir thoroughly until all kernels are coated.

In closed mixers the oil may be applied to the bait and mixed until all bait is coated. The powdered material may then be added in dry form. When using the anticoagulant on walnut meats, no oil is needed as the natural oiliness of nut meats will be sufficient.

BAIT FORMULAS

For Oregon Ground Squirrel

Strychnine Formula No. 1

Dandelion plants (including roots)	5 gallons
Strychnine (powdered alkaloid)	1 oz.
Bicarbonate of soda	1 oz.
Saccharin	1/10 oz.
Heavy corn sirup	4 ozs.
Thin starch paste	12 ozs.
Glycerin	½ oz.

Mix thoroughly the powdered strychnine, baking soda and saccharin. Crush all lumps of soda. To this add sirup and stir to a smooth, creamy paste. Over this pour thin hot starch paste and stir well. (The starch paste is made by dissolving dry gloss starch in a little cold water which is then added to the boiling water. Boil and stir constantly until a clear thin paste is formed.) Add glycerine and stir thoroughly, making sure that none of the heavy sirup paste sticks to the bottom of the container. Pour this mixture over the bait and mix well so that all bait is coated.

Fresh chicory may be used as a substitute. Green alfalfa leaves are less satisfactory.

Strychnine Formula No. 2

Strychnine coated whole oats for Oregon ground squirrels may be prepared with strychnine formula No. 1; substitute 25 lbs. oats for dandelions. When pouring the mixture over the oats, mix well so that each kernel is evenly coated.

C A U T I O N

All poison containers and all uncleaned utensils used in the preparation of poisons should be kept PLAINLY LABELED and OUT OF REACH of children, irresponsible persons and live stock.

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APPENDIX G

APPLICATION FOR REGISTRATION

1977

IMPORTANT

EXECUTE AND RETURN ALL COPIES EXCEPT APPLICANT'S. SEE ATTACHED INSTRUCTIONS.

STATE OF MONTANA

DEPARTMENT OF AGRICULTURE

PESTICIDE DIVISION

1300 Cedar Street — Helena, MT 59601

(406) 449-3730

Do Not Write in This Space
Date Rec'd.
Fee Rec'd.
Amount
C.K. or M.O. No.
Receipt No.
Date App'd.
Date Issued
Cert. No.

Application for Registration of Pesticides

Application is hereby made for registration of the pesticide(s) listed hereon for sale in Montana beginning with the actual date of registration and ending December 31, 19____. Submitted as part of this application are individual data sheets (8½ x 11) to which is attached a copy of the label for each product. (See Instructions)

Name of Applicant	Phone No.	Name of Manufacturer on Label, if not Applicant	
Montana Dept. of Livestock	449-2044	Same	
Authorized Representative		Attention	Phone No.
Kenneth Seyler			
Address		Address	
State Capitol, Dept. of Livestock			
City / State / Zip Code		City / State / Zip Code	
Helena MT 59601			

I, Kenneth Seyler of the MT. Dept. of Livestock
(Name of Applicant Firm)

hereby certify that the information on and accompanying this application is true and correct in every particular and that the labels and labeling sent herewith are exact copies of the labels and labeling that will be used on the product(s) named herein. It is agreed that the registration and sale of these compounds in Montana will be in accordance with the requirements of the Montana Pesticides Act, and regulations promulgated under the Act.

FEE: Ten ($10.00) Dollars Per Pesticide Registered

Signature of Authorized Firm Representative

Title Kenneth Seyler 5/23/77

Date Signed

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER

For use by Certified 1080 Government Pesticide Applicators only! Poison if swallowed. Use gloves when handling. Wash hands thoroughly before eating or smoking. Do not contaminate food and food stuff.

PHYSICIAN'S TREATMENT

Sodium monofluoroacetate exerts its action on the myocardium and central nervous system in primates and presumably in man. The effect on the heart is the primary cause of death in monkeys and takes the form of ventricular fibrillation. Early symptoms are alternation of the heart sounds and premature and weak contractions.

Central nervous system reaction is manifest by epileptiform convulsions.

TREATMENT: The treatment for sodium monofluoroacetate poisoning is mainly symptomatic. Immediate emesis and gastric lavage followed by oral doses of magnesium sulfate are useful. Administration of certain compounds capable of supplying acetate ions have shown antidotal effects in animals including monkeys; the choice drugs being monoacetin (glycerol monoacetate) (2 to 4 g./kg. of each). A single dose of magnesium sulfate (800 mg./kg.) given intramuscularly as a 50 percent solution has saved the life of rats dosed with lethal amounts of sodium monofluoroacetate. Complete quiet and rest are indicated, but barbiturates to the point of anesthesia have proved disappointing when used as antidotes against this poison.

Symptoms of non-lethal sodium monofluoroacetate intoxication will usually subside within 12-24 hours.

RESTRICTED USE PESTICIDE

For use only by Certified Government Pesticide Applicators in western Montana.

1080 GRAIN BAIT

For distribution and use only within Montana to control Columbian ground squirrels (Spermophilus columbianus).

Active Ingredient:	
1080 (Sodium Monofluoroacetate.....	.05%
Inert Ingredients.....	99.95%
Total.....	100.00%

Net Weight 10, 25, 50 lbs.

KEEP OUT OF REACH OF CHILDREN
DANGER - POISON

STATEMENT OF PRACTICAL TREATMENT

If swallowed, prompt treatment is essential. Immediately give a tablespoon of salt in a glass of warm water and repeat until vomit fluid is clear. Then give two tablespoons of Epsom Salt in water. Have victim lie down and keep warm and quiet. CALL A PHYSICIAN IMMEDIATELY!

If on skin, immediately flush with plenty of water.

SEE LEFT SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS AND PHYSICIAN'S TREATMENT STATEMENT.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds and other wildlife. Treated bait exposed on soil surface may be hazardous to birds and other wildlife. Keep out of lakes, ponds, or streams. Do not contaminate water by cleaning of equipment or disposal of wastes. May cause secondary poisoning in other animals. Pick up and burn or bury all carcasses of animals found killed by 1080.

DIRECTIONS FOR USE

It is a violation of federal and state law to use this product in a manner inconsistent with its labeling.

CATEGORY OF APPLICATOR

For use only by Certified Government Pesticide Applicators in Montana counties as specified in the use restrictions. For use to reduce agricultural resource losses caused by Columbian ground squirrels.

IMPORTANT-Before handling or placing 1080 bait, consult the Use Restriction Bulletin for specific use directions, additional precautions, and information related to non-target species protection.

STORAGE AND DISPOSAL

Storage - All 1080 grain bait shall be stored and transported in locked containers to prevent accidental exposure to any person or non-target animal.

Disposal - 1080 grain bait to be disposed of will be destroyed by burning or burial.

State of Montana
Montana Department of Livestock
24c Registrant
EPA SLN MT 77000
EPA Est. No._____

1080 GRAIN BAIT FORMULA

Grain (Oat Groats or Crimped Oats).....100 lbs.
Lecithin-Mineral Oil.....2/3 qt.
Water..... 1 qt.
Dye (Auramine O Conc. 130%).....1/2 oz.
Compound 1080 (Sodium Monofluoroacetate).... 1 oz.

Active Ingredient:
Sodium Monofluoroacetate .... 0.05 %
Inert Ingredients.....99.95 %

Heat water (do not boil) and add "1080"; stir until dissolved; add dye and stir; add lecithin-mineral oil and beat until a heavy cream-like emulsion forms. Pour mixture over grain and mix thoroughly. Spread and dry on clean surface. If the bait is to be used soon, it may be sacked without drying.

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